BULLETIN

OF THE INSTITUTE OF METALS

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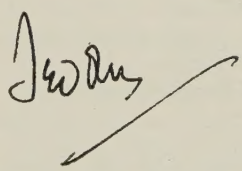
NEW YEAR MESSAGE FROM THE PRESIDENT

It was indeed an honour you paid me when you elected me as your President for the Jubilee year. I only regret that pressure of many commitments has prevented me from visiting Local Sections. The London and Birmingham meetings, however, were to me not only of absorbing interest but also an eye-opener as regards the wide and International field covered by the Institute. There are people who, in my view quite wrongly, blame the scientists for the dangers which threaten the world. The work of the Institute is, on the other hand, a striking example of the way in which science and technology are becoming International rather than National and are more and more by-passing the political barriers which still fret the world.

I would offer my sincere good wishes to all Members for a happy, constructive and peaceful new year. May our Institute continue to go from strength to strength, not least in its contributions to International understanding.



FORTHCOMING MEETINGS

" The Oxidation of Metals at High Temperatures "

DR. C. E. BIRCHENALL will give a lecture on " The Oxidation of Metals at High Temperatures " at the Institute's Headquarters, 17 Belgrave Square, London, S.W.1, on Thursday, 15 January, at 6.30 p.m. Dr. Birchenall, who is Associate Professor of Chemistry at Princeton University, U.S.A., is at present working at the Royal School of Mines. The lecture is one of a series given by scientists from abroad that has been arranged by the Metal Physics Committee in recent years.

Packaging of Metals

17 February, in Birmingham

The Institute is holding an Informal Discussion, arranged by the Metallurgical Engineering Committee, on " The Economic Protection and Packaging of Non-Ferrous Metals in Storage and Transit ", at the Birmingham College of Technology, Gosta Green, Birmingham 4, on Tuesday, 17 February. The meeting will start at 10.30 a.m. with two opening addresses, and will end at about 4.30 p.m. Visitors will be welcome; tickets are not required.

Informal Discussion on " Theoretical Aspects of Sintering "

12 March, in London

An Informal Discussion on " Theoretical Aspects of Sintering ", arranged by the Powder Metallurgy Joint Committee, will be held on 12 March at Church House, Great Smith Street, Westminster, S.W.1. The papers on which the discussion will be based will be printed in advance of the meeting in *Powder Metallurgy*, the new publication of the Powder Metallurgy Joint Group (for which each member may enter one subscription each year at the privileged rate of 10*s*., post free).

Spring Meeting

14–16 April, in London

The Spring Meeting will be held in London, from Tuesday to Thursday, 14–16 April, inclusive. The business and scientific sessions will be at Church House, Great Smith Street, Westminster, S.W.1.

The full programme of the meeting, which will be published in next month's issue of the *Bulletin*, will include:

Tuesday, 14 April:

Morning: Annual General Meeting; induction of new President; Presidential Address; presentation of medals.

Afternoon: Scientific session or sessions.

Evening: May Lecture (at the Royal Institution).

Wednesday, 15 April:

Morning: Two concurrent sessions for the discussion of papers, including ones on the Properzi process and the Hazelett and rotary casting processes.

Afternoon: Two concurrent sessions for the discussion of papers, including ones on vacuum melting and arc melting.

Evening: DINNER and DANCE at Grosvenor House.

Thursday, 16 April:

All-day: Symposium on " Practical Aspects of Metal Physics ", comprising—after a general introduction by Professor A. H. Cottrell, F.R.S.—a series of lectures, of an educational character, on: solidification, including zone refining; mechanical forming; properties of creep-resistant alloys in relation to structure; electrical properties; and radiation damage. Questions will be answered but there will be no discussion.

Evening: CONVERSAZIONE AND EXHIBITION (day dress) at 17 Belgrave Square. Members and organizations with scientific and technical exhibits to offer should communicate with the Secretary as early as possible.

Instructional Meetings for Younger Members

7–9 May, in the Midlands

With the approval of the Managing Directors of many of the important companies in the non-ferrous metals industry, the Council has agreed to a proposal of the Metallurgical Engineering Committee that instructional meetings be held for younger members of the Institute who are engaged in the industry. The intention is to encourage the study and discussion of specific problems in the works.

The meetings will normally last two days (covering two nights in residence) and will be held in industrial centres once only in any year. Those participating will be required to live throughout the meetings in the accommodation arranged by the Institute, and the inclusive charges for accommodation, meals, and local transport will be kept as low as possible. Senior persons in the industry will be present and act as directors of study or lecturers at each of the meetings.

Each meeting will have a definite object, and visits to plants will be restricted to the particular aspects under study.

The first of these meetings will be held in the Midlands from Thursday to Saturday, 7–9 May 1959. Details are given below:

Accommodation: Ashorne Hill, near Leamington Spa.

Topic for study: Design and operational aspects of melting furnaces in the non-ferrous industry.

Subjects of study by syndicates:

(i) Choice of optimum type, shape, and size for specific duties.

(ii) Preparation of heats and methods of charging.

(iii) Relative merits of various fuels and methods of firing.

(iv) Control systems for improving operational efficiency.

(v) Furnace linings and their maintenance.

(vi) Ventilation and fume removal and other factors affecting layout.

Directors of Studies: Mr. C. Paton (Northern Aluminium Co., Ltd.), and Mr. J. Salter (The British Aluminium Co., Ltd.).

Works to be visited: Melting shops of James Booth and Co., Ltd., Kitts Green, Birmingham, and Imperial Chemical Industries, Ltd., Metals Division, Witton, Birmingham, by kind permission of the Chairmen.

Provisional programme:

Thursday: Students report in time for dinner. 9 p.m. Opening address by a Director of Studies, followed by briefing of syndicates.

Friday: Visits to works (morning and afternoon). 5.30 p.m. Initial meetings of syndicates. 7 p.m. Dinner, followed by resumption of discussions by syndicates.

Saturday: Completion of syndicate reports. 11.30 a.m.

Presentation of syndicate reports and discussion. 5 p.m. Closing address by a director of studies.

Certain senior members in the industry will be present to assist the syndicates.

Members who wish to participate in this meeting, should notify the Secretary. It is hoped that Managing Directors of many companies will encourage and assist younger members of their staffs to attend this meeting, which, it is emphasized, is instructional. Particulars of cost will be published later.

Autumn Meeting

21–28 September, in Sweden and Denmark

The 1959 Autumn Meeting will be held in Sweden and Denmark from Monday, 21 September, to Monday, 28 September, inclusive. The meeting will open in Stockholm on Monday, 21 September; in addition to numerous visits from Stockholm, there will be an all-day visit to Västerås on the Wednesday, and on the Friday there will be visits to Boliden, Falun, and Finspong. On the Friday evening, members and ladies (excepting those visiting Boliden) will leave for Copenhagen, arriving on the Saturday morning. There will be visits in Copenhagen on Monday, 28 September, and the meeting will close on the evening of that day.

Fuller details, including arrangements made for accommodation and travel by Thomas Cook and Son, Ltd., will be published as early as possible.

OTHER INSTITUTE NEWS

Election of Members

The following 24 Ordinary Members, 4 Junior Members, and 32 Student Members were elected on 20 November 1958:

As Ordinary Members

ASHWORTH, Derek Ralph, M.Sc., A.Inst.P., Senior Research Metallurgist, C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne 6.

BEST, Peter, B.Sc., Chief Ceramist, Rolls-Royce, Ltd., Derby.

BLACK, Charles Wilfred, F.L.A., City Librarian, The Mitchell Library, Glasgow, C.3.

BRINSON, Geoffrey, M.Sc., Research Worker, Department of Metallurgy, University of Sheffield.

CABOZ, Régis Franz André, Lic. ès Sci., Laboratoire de Recherches, Ecole Nationale Supérieure d'Electrochimie et de l'Electrométallurgie, 44 Boulevard Gambetta, Grenoble, France.

DARBY, Joseph Branch, Jr., M.S., Ph.D., Metallurgist, Alloy Properties Group D-19, Argonne National Laboratory, Lemont, Ill., U.S.A.

DELAUNAY, Georges, Ing., Directeur, Centre de Documentation Sidérurgique, 6 rue de Lotta, Paris 16e, France.

FORBES, Hugh Donald, B.A.Sc., Superintendent, Technical Division, Aluminium Company of Canada, Ltd., Shawinigan, P.Q., Canada.

FULLER, John Christopher, General Manager, Mallory Metallurgical Products, Ltd., Exhibition Grounds, Wembley, Middlesex.

HEAL, Thomas John, M.Sc., F.Inst.P., F.I.M., Research Manager, Culcheth Laboratories, U.K. Atomic Energy Authority (Industrial Group), Culcheth, Lancs.

HUNT, Gilbert Adams, Director and General Manager, High Duty Alloys, Ltd., Slough, Bucks.

JOSEFSSON, Erik Anders Ake, Assistant to Director of Research, Stora Kopparbergs Bergslags AB, Domnarvet, Sweden.

KUST, Robert R., M.S., Metallurgist, Research Laboratories, Allis-Chalmers Manufacturing Co., Box 512, Milwaukee 1, Wis., U.S.A.

LANDAUER, Richard, Director, Derby and Co., Ltd., 11/12 St. Swithin's Lane, London, E.C.4.

LEVESQUE, Pascal, M.A., B.Appl.Sci., Ph.D., Head of Metallurgy, Research Division, Raytheon Manufacturing Co., Waltham 54, Mass., U.S.A.

NAUSS, Joseph Gerald, B.S., Plant Metallurgist, Bridgeport Brass Co., Aluminum Division, Adrian, Mich., U.S.A.

OCHI, Andrea, Ing.Dipl., Chim., Spectrograph., Vice-Capo, Laboratorio Controllo e Ricerche, Trafilene e Laminatoi di Metalli S.p.A., Milano, via Sile 8, Italy.

SCHWARZ, Heinrich Gabriel, Dr.rer.pol., Sales Manager, The Roditi International Corporation, Ltd., Bohler Steel Division, 12a Golden Square, London, W.1.

SMITH, Robert Worth, B.S., Ph.D., Supervisor, Physics and Metallurgy Laboratories, A. C. Spark Plug Division, General Motors Corporation, Flint, Mich., U.S.A.

SVOBODA, Miroslav, Ing., Reditel, Státni výzkumný ústav materiálu a technologie, Opletalova 25, Praha 3, Czechoslovakia.

THOMAZ, Luiz Pinto, Director-Superintendente, Industria Metalurgica N. S. Aparevida S/A, Rue 15 de Novembro 244, São Paulo, Brazil.

WAHL, Claude André, Directeur-Général, Societé "Zinc et Alliages", 34 rue Collange, Levallois-Perret (Seine), France.

WARIN, Peter Edwin, A.B.C.T., Research Metallurgist, Siemens Edison Swan Research Laboratory, Harlow, Essex.

WILSON, Robert, Works Metallurgist, Timex, Branch of United States Time Corporation, Harrison Road, Dundee.

As Junior Members

BAKER, Thomas Neville, B.Met., Research Metallurgist, The English Electric Co., Ltd., Nelson Research Laboratories, Stafford.

BEDELL, Edward L., M.S., Metallurgist, Research Laboratories, Allis-Chalmers Manufacturing Co., Box 512, Milwaukee 1, Wis., U.S.A.

KENNON, Noel Frederick, Teaching Fellow, School of Metallurgy, New South Wales University of Technology, Kensington, N.S.W., Australia.

MATTHEWS, Jon Michael, B.Sc., Assistant Experimental Officer, Metallurgy Division, Atomic Energy Research Establishment, Harwell, Berks.

As Student Members

CALLCUT, Vincent Allen, L.I.M., Research Assistant, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

CARRUTHERS, Robert Brian, Undergraduate, Department of Metallurgy, King's College, Newcastle-upon-Tyne.

CHAPMAN, John Anthony, Undergraduate, Department of Industrial Metallurgy, University of Birmingham.

COLLEY, Andrew Hilton, Junior Technical Assistant, D. Napier and Son, Ltd., London, W.3.

DAVIES, Dillwyn Morgan, B.Sc., Research Student, Department of Metallurgy, University of Oxford.

ELVIN, Jack, B.Sc., Metallurgist, Vickers-Armstrongs (Aircraft), Ltd., Weybridge, Surrey.

FARRAR, Roy Alfred, Undergraduate, Royal School of Mines, University of London.

GABE, David Russell, B.Sc., Postgraduate Student, Department of Physical Metallurgy, University of Sheffield.

GRAVES, Peter William, Undergraduate, Department of Physical Metallurgy, University of Birmingham.

HOLLINGWORTH, Arthur, Metallurgical Assistant, The Mint Birmingham, Ltd., Icknield Street, Birmingham 18.

KOTHARI, Navin, C.M., B.Sc., Student, Department of Engineering Research, North Carolina State College, Raleigh, N.C., U.S.A.

KRISHNAN, Kamala Sivasubramaniam, M.A., Student, Department of Metallurgy, Indian Institute of Science, Bangalore, India.

LAIRD, Campbell, Undergraduate, Department of Metallurgy, University of Cambridge.

LEE, Kenneth Trevor, Undergraduate, Department of Metallurgy, University of Sheffield.

MAKOWER, Michael Stanley, Undergraduate, Department of Metallurgy, University of Cambridge.

MARTIN, Norman, Undergraduate, Department of Metallurgy, University of Cambridge.

DE MEESTER, Paul Jozef August, Burg.Met.Ir., Research Assistant, Towne Building 206, University of Pennsylvania, Philadelphia 4, Pa., U.S.A.

MULLER, Tobias Lefebre François, B.Sc., Metallurgist, Union Steel Corporation (S.A.), Ltd., P.O. Box 48, Vereeniging, South Africa.

NEWBIGGING, Alastair William Patterson, B.Sc., Metallurgist, High Duty Alloys, Ltd., Winscales, Workington.

ÖZTÜRK, Yildirim, B.Sc., Postgraduate Student, Department of Metallurgy, University of Sheffield.

PAINTER, Donald Reginald, Student Metallurgist, S. Smith and Sons (England) Ltd., Witney, Oxon.

PROEBSTLE, Richard Alan, M.S., Graduate Student, 1133 South Country Club Drive, Schenectady, N.Y., U.S.A.

PRUGAR, Andrzej Kazimierz Tadeusz, B.A., Research Student, Department of Metallurgy, University of Oxford.

RAGHAVAN, Krishnaswami Srinivasa, B.Sc., D.I.I.Sc., Research Assistant, School of Metallurgical Engineering, University of Pennsylvania, Philadelphia 4, Pa., U.S.A.

ROBERTS, Philip McPherson, Metallurgist, Harlow Metal Co., Harlow, Essex.

ROSS, Russell George, B.A.Sc., Research Student, Department of Metallurgy, University of Oxford.

SANDERSON, George Patrick, A.Met., L.I.M., Technical Apprentice, Samuel Fox and Co., Ltd., Stockbridge, Sheffield.

SMALES, Richard, Undergraduate, Department of Metallurgy, University College of Swansea.

WADE, Richard Harry, Undergraduate, Department of Metallurgy, University of Cambridge.

WHYBROW, Peter John Leonard, B.Sc., Research Student, Birmingham College of Advanced Technology, Gosta Green, Birmingham 4.

WOODWARD, Foster, Undergraduate, Department of Metallurgy, University of Cambridge.

WRIGHT, Michael George, Undergraduate, Department of Metallurgy, University College of Swansea.

PERSONAL NOTES

MR. D. DEW-HUGHES has left the Hammond Metallurgical Laboratory, Yale University, and is now with the Semi-Conductor Division of the I.B.M. Research Laboratory, Poughkeepsie, N.Y.

MR. E. H. DIX, JR., who recently retired from the position of Assistant Director of Research to the Aluminum Company of America, has been awarded the U.S. Navy's highest civilian honour—the Distinguished Public Service Award—for his outstanding contributions to the Navy in the fields of scientific research and development.

DR. H. M. FINNISTON has left Harwell to become Research Manager of the nuclear research centre of C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne.

DR. ANDREW FLETCHER, President of St. Joseph Lead Company, has become President of United Engineering Trustees, Inc. This organization was set up in 1904 to advance the engineering arts and sciences.

MR. M. W. HARVEY has left Cambridge University and joined the Research Division, High Duty Alloys, Ltd., Slough.

DR. H. H. HAUSNER, of the Nuclear Engineering Division of the Penn-Texas Corp., New York, has been elected President of the International Plansee Society.

MR. S. R. A. LANGFORD has left J. Stone and Co. (Charlton), Ltd., to take up an appointment as Works Metallurgist in the Non-Ferrous Metals Department of the Scotswood Works of Vickers-Armstrongs (Engineers), Ltd., Newcastle-upon-Tyne.

DR. T.-S. LIU has left the Titanium Metals Corp. and is now at the Southwest Research Institute, San Antonio, Texas.

MR. H. MCARTHUR has left Cambridge University and joined the English Electric Co., Ltd., Leicester.

MR. J. A. SABATO has returned to Buenos Aires after a period spent in research at the Department of Physical Metallurgy, University of Birmingham. He resumes his position as Head of the Metallurgy Division of the Argentine Atomic Energy Commission.

DR. O. D. SHERBY has returned to the United States after serving for a time in the U.S. Office of Naval Research, London. He is now at the Department of Metallurgical Engineering, Stanford University, Stanford, Calif.

MR. Z. STOKOWIEC has been appointed to the Board of Tyseley Metal Works, Ltd.

MR. G. SWINYARD has been appointed Chief Metallurgist of The Phosphor Bronze Co., Ltd., Birmingham.

MR. R. TURNER has been appointed Joint Managing Director of Johnson, Matthey and Co., Ltd., Hatton Garden, London.

Deaths

The Editor regrets to announce the death of:

Ir. JACOB LODDER, Chief Metallurgist, Maatschappij tot Exploitatie van Kooksovengassen N.V., Ijmuiden, Netherlands, on 18 August 1958.

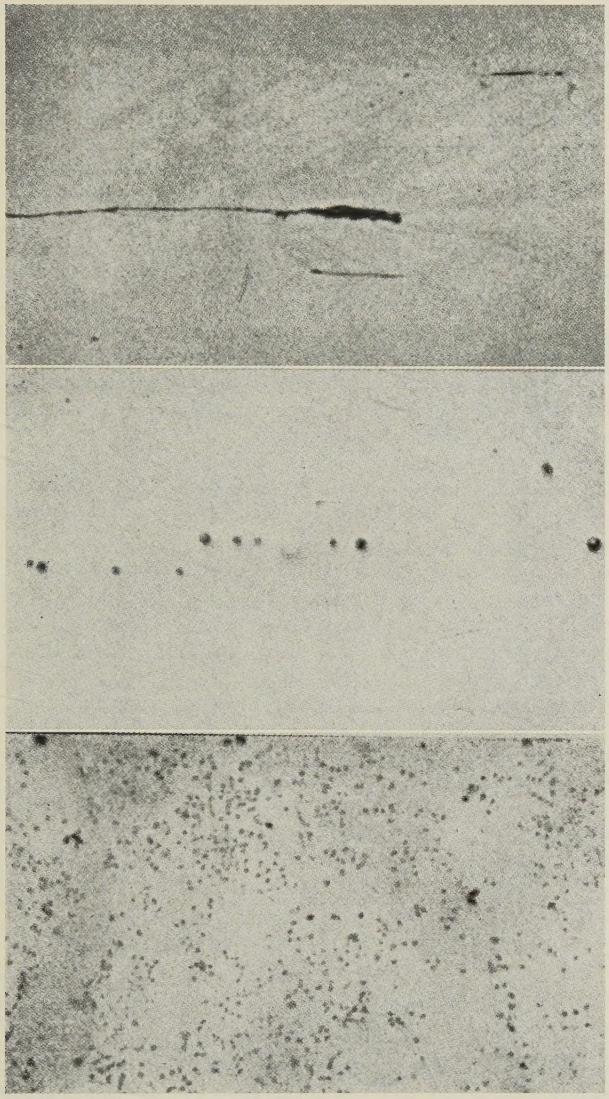
Professor ARCHIBALD PREECE, of King's College, University of Durham, on 13 November 1958.

LETTERS TO THE EDITOR

Observation of Traces of Cuprous Sulphide in O.F.H.C. Copper

MR. D. R. MILLER [1] has published a note on the micrographic observation of cuprous sulphide precipitate in O.F.H.C. copper slowly cooled after heating at a high temperature *in vacuo*. May I point out that I studied this subject more than 13 years ago and published a paper entitled " On the Application of Electrolytic Polishing to Copper Micrography ".[2]

The three micrographs given in the above paper, and reproduced here (Figs. 1–3), correspond to an O.F.H.C. copper of American origin, whose sulphur content was about 0·003%, with very slight traces of selenium and tellurium. They show clearly: (1) the presence of filaments oriented parallel to the rolling direction (Fig. 1); (2) the dissolution of these filaments during heating at 850° C. followed by water-quenching (Fig. 2); (3) reprecipitation in the form of dispersed and very minute particles when heating *in vacuo* is followed by slow cooling (Fig. 3).



1

2

3

← Rolling direction →

ROLLED O.F.H.C. COPPER

FIG. 1.—Containing cuprous sulphide (+ selenide + telluride). ×250.
FIG. 2.—Annealed 30 min. at 850° C. in nitrogen and water-quenched. ×600.
FIG. 3.—Annealed 30 min. at 850° C. *in vacuo* and slowly cooled. ×600.

I also noted that very light rubbing of the surface of the specimen shown in Fig. 3 was sufficient to cause these fine particles to disappear, thus confirming that they were formed by a constituent and were not due to pitting resulting from the electrolytic polishing.

This phenomenon explains also why it is impossible to see the faintest trace of this constituent out of solution in the O.F.H.C. copper specimens prepared by mechanical polishing.

Traces of cuprous sulphide have also been found in electrolytic copper melted *in vacuo*. The distribution of this impurity in the interdendritic regions leads to a curious phenomenon, namely the persistence of the cast macrostructure in sheets rolled from the ingot. This question has been discussed in detail in another paper of mine.[3]

PIERRE A. JACQUET.

Saint-Mandé (Seine),
France.

REFERENCES

1. D. R. Miller, *Bull. Inst. Metals*, 1958, **4**, (6), 35.
2. P. A. Jacquet, *Rev. Mét.*, 1945, **42**, 133.
3. P. A. Jacquet, *Métaux-Corrosion-Usure*, 1945, **20**, 137.

On the Annealing Kinetics of Plastically Deformed Metals

ANOMALIES in the behaviour of measured physical properties, usually taken to indicate the different aspects of annealing of a cold-worked metal, imply that a work-softened state cannot be adequately described by a single parameter, such as, for example, the density of dislocations. Cottrell and Stokes [1] introduced another parameter involving the distribution of dislocations. Even so some of the observed anomalies [2] in internal-friction and elastic-modulus measurements could not be adequately explained as based solely on Cottrell and Stokes's concept. Mott [3] introduced the idea, which was subsequently confirmed by others,[4] that vacancies as well as dislocations are created during plastic deformation. The effect of such point defects on mechanical properties has recently been shown [5] to be of such great importance that the role they play in annealing kinetics cannot be disregarded. A new parameter involving the interaction of these defects and of impurity atoms with dislocations is now proposed. On the basis of internal-friction and elastic-modulus measurements, the following discussion is an attempt to throw more light on the still rather mysterious aspects of the atomic behaviour during work-softening.

It is well known that a work-softening process increases the elasticity of the recovered material, while its damping is decreased. Recently, a rise in internal friction accompanied by a parallel decrease in the elastic modulus during the high-temperature annealing of heavily cold-worked cadmium has been reported.[6a] A plausible interpretation of this behaviour is that the rise in internal friction is caused by the freeing of more dislocations (contributing to energy loss) from piled-up groups through a process of climbing and polygonization. Since climbing of dislocations is a vacancy-creating mechanism,[3] hardening is effected as well.

A different type of internal friction increase associated with an increase in elasticity has been observed [2b] during the recovery of slightly deformed copper. A description of the atomic mechanism responsible for this abnormality may be obtained from a recent study [7] of quenched gold in which Roswell and Nowick were able to detect a state where the dislocations were so lightly pinned that even slight mechanical disturbances could easily shake them free from their pinning points. Applying the same view to the lightly pinned dis-

locations generally created in the earlier stages of deformation, we can thus satisfactorily explain the anomalous rise in internal friction with the ageing time after straining. The associated elastic modulus, unaffected by this hypothesis, increases continuously as the dislocation density decreases on ageing, tending to an equilibrium state. The sharp rise in some of the internal-friction curves observed in the same investigation [2b] seems to depend upon the degree of locking of these lightly pinned dislocations, which probably varies according to the rate with which the plastic deformation is applied.

As regards the effects of impurity atoms on the recovery process, it is known [5] that dislocations attract foreign atoms, and that these precipitate at the dislocation lines, locking the dislocations at these points. An energy equal to the binding energy of this system must be provided before the dislocation becomes mobile again and able to contribute to internal friction. This impurity-locking mechanism was found to affect the internal friction in earlier stages of plasticity,[2] whereas it did not do so during heavy deformations.[6b] Again the role of vacancies is unmistakable. Since vacancies interact with dislocations in a rather similar way to impurity atoms, both being point defects, the increasing number of vacancies created as the degree of deformation increases would mask the effect of the impurity atoms, and this apparently renders the variations in internal friction purity-insensitive.

R. KAMEL.*

Physics Department,
University of Cairo.

REFERENCES

1. A. H. Cottrell and R. S. Stokes, *Proc. Roy. Soc.*, 1955, [A], **233**, 17.
2. (*a*) A. D. N. Smith, *Phil. Mag.*, 1953, [vii], **44**, 453.
   (*b*) A. S. Darling, *J. Inst. Metals*, 1956, **85**, 489.
3. N. F. Mott, *Phil. Mag.*, 1952, [vii], **43**, 1151; 1953, [vii], **44**, 178, 742.
4. F. Seitz, *Advances in Physics*, 1952, **1**, 43.
   H. G. van Bueren, *Acta Met.*, 1955, **3**, 519.
5. A. H. Cottrell, "Symposium on Vacancies and Other Point Defects in Metals and Alloys" (Inst. Metals Monograph No. 23), pp. 14–22. **1957**: London (Institute of Metals).
6. (*a*) R. Kamel and E. A. Attia, *J. Appl. Physics*, 1957, **28**, 1365.
   (*b*) R. Kamel and E. A. Attia, *Bull. Inst. Metals*, 1958, **4**, (9), 56.
7. A. E. Roswell and A. S. Nowick, *Acta Met.*, 1957, **5**, 228.

POWER METALLURGY JOINT GROUP

Symposium on "The Powder Metallurgy of Ceramic–Metal Materials"

At a meeting of the Powder Metallurgy Joint Group on 17 December, a Symposium was held on "The Powder Metallurgy of Ceramic-Metal Materials". Synopses of six specially invited papers are printed below. The full papers are to be found in the first issue of *Powder Metallurgy*, which is the official publication of the Joint Group. Details of it were given in the November issue of the *Bulletin* (p. 113). *Powder Metallurgy* is obtainable by annual subscription at 25*s.* (post free) to non-members, with a privileged rate of subscription to members of The Iron and Steel Institute and The Institute of Metals of 10*s.* (post free).

Recent Developments in the Field of Silicides and Borides of the High-Melting-Point Transition Metals

By R. Kieffer and F. Benesovsky
(*Metallwerk Plansee A.G., Reutte/Tirol*)

The binary systems of silicides of the high-melting-point transition metals are now well understood, except for the hafnium–silicon system. Research since 1954 is reviewed, with particular reference to the compound Me_5Si_3 and its position in the silicide systems. Reference is also made to the pseudo-binary and pseudo-ternary silicide systems.

The structures of many of the intermetallic phases in the binary boride systems have now been determined, but complete equilibrium diagrams still remain to be established in some cases. New tentative diagrams are given for the systems vanadium–boron, niobium–boron, and tantalum–boron, and structures are suggested for the borides V_3B_2, Nb_3B_2, and Ta_3B_2 with the *T*2 structure (isostructural with U_3Si_2).

Ternary alloys of the systems *Me*–Si–B are of great interest, not only structurally but also for practical reasons. The complete systems *Me*–Si–B of Group VI (Mo–Si–B and W–Si–B) have accordingly been studied by X-ray, thermal-analysis, and micrographic methods. The system Cr–Si–B has been determined and attention is directed to the possible commercial applications of certain alloys containing additions of metals of the iron group, in particular nickel, for sprayed coatings resistant to liquid aluminium.

The question of cementing silicides and borides with metals and alloys is discussed theoretically. The character of the silicide or boride system in question and the behaviour of the intermediate phase in relation to the bonding material are of decisive importance for the selection of the latter. Only very limited data are to be found in the literature on the behaviour of silicides and borides in relation to metals and alloys. Alloys based on TiB_2, ZrB_2, $MoSi_2$, and WSi_2, impregnated with numerous metals and alloys, have been prepared. Their structures have been studied and the technical suitability of various combinations is discussed on the basis of their technological properties.

Bonding in Carbides, Silicides, and Borides

By D. A. Robins
(*Research Laboratories of The General Electric Co., Ltd., Wembley*)

The hypothesis that many of the properties of the transition metals, their alloys, and their compounds can be understood in terms of a relationship between the co-ordination of the metal atoms and the number of bonding electrons per atom, is applied to the carbides, silicides, and borides of the transition metals of Group IVA, VA, and VIA. The crystal structure and stability of the carbides can be satisfactorily explained on the basis of electron concentration, but a complete understanding of the bonding in the silicides and borides is more difficult. In the silicides the metal–silicon bonding, which is metallic in character, becomes of increasing importance as the silicon content is increased, and in the disilicides no direct metal–metal bonding remains. The ability of boron to form strong boron–boron bonds is important in the borides, and the metal–metal co-ordination would appear to be of only secondary importance. The practical significance of the principles put forward is discussed.

* Now in the H. H. Wills Physics Laboratory, University of Bristol.

The High-Temperature Properties of Ceramics and Cermets

By E. Glenny and T. A. Taylor

(*National Gas Turbine Establishment, Farnborough, Hants*)

It has been recognized for some time that, with progressive increase in the working temperature of gas turbines, metallic alloys may no longer be adequate for rotor or stator blading. The use of more refractory but more brittle materials, i.e. ceramics and ceramic–metal mixtures (cermets) has been suggested. The paper is concerned with the evaluation of the major properties involved, viz. creep strength, fatigue strength, resistance to thermal fatigue (i.e. to repeated thermal shocks), oxidation-resistance, and impact-resistance. The materials evaluated include oxides, oxide–metal cermets, carbides, carbide–metal cermets, molybdenum disilicide, and silicon nitride. The equipment for determining the effects of alternating and steady mechanical stresses up to 1200° C. is described. The relative merits of the test materials are discussed. It is concluded that the resistance to thermal fatigue and to impact of the ceramics and cermets is inferior to that of metallic alloys in current use.

The Oxidation of Zirconium Carbide in High-Temperature Combustion Gases

By W. Watt

(*Royal Aircraft Establishment, Farnborough, Hants*)

The reactions of sintered zirconium and titanium carbides have been studied in simulated rocket combustion gases at surface temperatures of about 2250° C. Under these conditions zirconium carbide is oxidized according to a parabolic law owing to the formation of an adherent oxide film. No oxide film is formed on titanium carbide under the same conditions, and it decreases in weight and dimensions at a relatively rapid rate.

The Fabrication and Properties of Chromium–Alumina and Molybdenum–Chromium–Alumina Cermets

By J. B. Huffadine, L. Longland, and N. C. Moore

(*The Plessey Co., Ltd., Towcester, Northants*)

After a brief review of the literature, various methods for preparing chromium–alumina and molybdenum–chromium–alumina cermets are described. The properties of such materials are discussed, and an indication is given of their possible applications.

The Fabrication and Properties of Uranium Oxide–Iron Cermets

By W. J. Wright, R. B. Gibbon, and J. Williams

(*Atomic Energy Research Establishment, Harwell*)

Cermets of iron–uranium dioxide, containing up to 30 vol.-% UO_2 have been rolled to rod. Although the cores rolled centrally along the length, the core was distorted in section owing to stiffening of the core relative to the sheath as the temperature dropped during rolling. The UO_2 particles were fragmented during rolling and formed as "stringers" along the direction of rolling, seriously weakening the structure transversely.

By extrusion at 1200° C., cermets containing up to 50 vol.-% UO_2 were satisfactorily fabricated. The extrusion pressure increased sharply above 35 vol.-% of ceramic and when large reductions in area were taken. The extrusion characteristics do not conform to isotropic plastic extrusion nor to a pure viscosity effect; the influence of the dispersed particles on metal flow is explained by a strong interference effect between particles and the metal during flow. The properties of the extruded rods were good; the core density was 90–95% of theoretical, decreasing slightly with increasing ceramic content; there were no obvious directional properties in the core, nor was the ceramic fragmented as in rolling. The characteristic "tail-end defect" of the extrusions was partly corrected by using shaped sealing plugs.

OTHER JOINT ACTIVITIES

Mond Nickel Fellowships

The Mond Nickel Fellowships Committee announced recently the award of Fellowships for 1958 to the following applicants:

Mr. G. H. Longworth (Lancashire Steel Manufacturing Co., Ltd.) to study the manufacture of plain carbon and alloy steels for rod and wire products in the United Kingdom, on the Continent, and in the United States.

Mr. J. C. Morrison (Carron Company) to study melting, moulding, and heat-treatment of alloy cast irons, quality control of metal and sand plants in modern foundries, and new developments in related metallurgical processes.

Mr. T. Tait (Colvilles, Ltd.) to study the technical and economic factors involved in the use of oxygen in steel industries in the United Kingdom, on the Continent, and in the U.S.A. and Canada.

The Mond Nickel Fellowships Committee now invites applications for Fellowships of an approximate value of £900 to £1200 for 1959. Fellowships will be awarded to selected candidates of British nationality with degree or equivalent qualifications to enable them to obtain wider experience and additional training in industrial establishments, at home or abroad, to make them more suitable for future employment in senior technical and administrative positions in British Metallurgical Industries. Each Fellowship will cover one full working year. Applicants will be required to state details of the programme they wish to carry out. Particulars and forms of application are available from: The Secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1.

Completed application forms are required by the 1 June 1959.

OTHER NEWS

Deutsche Gesellschaft für Metallkunde

The 1959 Annual Meeting of the Deutsche Gesellschaft für Metallkunde will take place in Würzburg on 28–31 May.

17th International Congress of Pure and Applied Chemistry

The 17th International Congress of Pure and Applied Chemistry will be held in Munich from 30 August to 6 September 1959, in conjunction with the 20th Conference of the International Union of Pure and Applied Chemistry (26–29 August).

The main subject of the Congress will be inorganic chemistry, and within this field it is proposed to discuss, *inter alia*, compounds with metal–carbon bonds, hydride chemistry, the chemistry of actinides and lanthanides, preparation of super-purity metals, semi-conductors and compounds of semi-metals, and ternary oxides and sulphides.

A circular dealing with the Congress may be obtained from the Generalsekretariat des XVII. Internationalen Kongresses für reine und angewandte Chemie, Meisserstrasse 1, München.

Exhibition of Research on Prevention of Corrosion

The Corrosion Group of the Society of Chemical Industry is again organizing an exhibition relating to prevention of metallic corrosion at the Battersea College of Technology, Battersea Park Road, London, S.W.11, on Thursday and Friday, 22 and 23 January 1959. The main theme of the exhibition is the apparatus and techniques used for research and for control of anti-corrosion processes, but recent developments in other fields will also be shown.

On Thursday, 22 January, the exhibition will be open, from 6.30 p.m., only to members and their friends attending the Group's Annual Conversazione, and tickets will be required.

On Friday, 23 January, the exhibition will be open to all without ticket from 9.30 a.m. to 3.30 p.m.

International Convention on Transistors and Associated Semi-Conductor Devices

The date of this Convention, some details of which have already been published (October *Bulletin*, p. 110), has now been changed to 21–27 May 1959. It will be held at Earl's Court, London, S.W.5. Particulars of the Convention and registration forms may be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

" Some Uses and Applications of Radio-isotopes "

A course of nine lectures on " Some Uses and Applications of Radioisotopes " will be given at the Battersea College of Technology, at 7.0 p.m. on Tuesday evenings from 13 January to 10 March 1959. The fee for the course is £1. Enrolment forms may be obtained from the Secretary (Chemistry Courses), Battersea College of Technology, Battersea Park Road, London, S.W.11.

DIARY

The Institute

15 January. " The Oxidation of Metals at High Temperatures ", by Dr. C. E. Birchenall. Lecture arranged by the Metal Physics Committee. (17 Belgrave Square, London, S.W.1, at 6.30 p.m.)

17 February. Informal Discussion on " The Economic Protection and Packaging of Non-Ferrous Metals in Storage and Transit ". (Birmingham College of Technology, Gosta Green, Birmingham 4, at 10.30 a.m.)

Local Sections and Associated Societies

3 February. East Midlands Metallurgical Society. Members' Night. Short papers presented by members. (Electricity Demonstration Theatre, Carrington Street, Nottingham, at 7.30 p.m.)

3 February. Oxford Local Section. " New Metals: The Rare Earths ", by Professor A. D. McQuillan. (Cadena Café, Cornmarket Street, Oxford, at 7.0 p.m.)

3 February. South Wales Local Section. " Progress in the Metallurgy of Deep Drawing and Pressing ", by Dr. D. V. Wilson. (Department of Metallurgy, University College, Singleton Park, Swansea, at 6.30 p.m.)

4 February. Manchester Metallurgical Society. " Micro-Mechanism of Fracture ", by Professor W. S. Owen. (Manchester Room of the Central Library, Manchester, at 6.30 p.m.)

5 February. Birmingham Local Section. Students' Evening. (College of Technology, Gosta Green, Birmingham 4, at 6.30 p.m.)

5 February. London Local Section. " Metallurgical Information ", by B. Fullman. (17 Belgrave Square, London, S.W.1, at 6.30 p.m.)

9 February. Scottish Local Section. Lecture by Professor J. G. Ball. (Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2, at 6.30 p.m.)

12 February. Leeds Metallurgical Society. " Operational Research in the Steel Industry ", by D. Jordan. (Lecture Room C, Chemistry Wing, The University, Leeds 2, at 7.15 p.m.)

12 February. Liverpool Metallurgical Society. " The Russian Steel Industry ", by R. Wilcock. (Joint Meeting with the Iron and Steel Institute.) (Library of the Department of Metallurgy, University of Liverpool, 146 Brownlow Hill, Liverpool 3, at 7.0 p.m.)

18 February. Manchester Metallurgical Society. " High-Temperature Alloys ", by D. R. Wood. (Manchester Room of the Central Library, Manchester, at 6.30 p.m.)

19 February. Birmingham Local Section. " Materials for Reactors ", by Dr. B. C. Woodfine. (College of Technology, Gosta Green, Birmingham 4, at 6.30 p.m.)

19 February. North East Metallurgical Society. " Metallurgical Education ", by Professor G. V. Raynor. (Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, at 7.15 p.m.)

26 February. Sheffield Local Section. Symposium on Corrosion. Three or four short papers will be given by invited speakers, followed by a general discussion. (Engineering Lecture Theatre, The University, St. George's Square, Sheffield 1, 2.0–5.30 p.m.)

26 February. Southampton Metallurgical Society. " Gases in Metals ", by Dr. C. E. Ransley. (Small Physics Lecture Theatre, The University, Southampton, at 7.15 p.m.)

APPOINTMENTS VACANT

BIRLEC HEATING DIVISION Sales Department want furnace design engineer. Duties include discussion with customers and liaison with engineering department designers and estimators, and preparation of project and tender specifications. H.N.C. or engineering degree standard. Apply to Personnel Manager, (JMP) Birlec, Ltd., Tyburn Road, Birmingham 24.

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